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# PERFORMANCE ANALYSIS FOR RING SHAPED ANTENNA IN UNDERWATER RADIO COMMUNICATION

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**ABSTRACT**

An underwater communication antenna is specifically designed for underwater-telemetry applications. It mainly radiates perpendicularly to the planar structure and the ground plane efficiently shields the underwater partials. It is most suitable for integration into clothing because of its various advantages such as low volume, low profile planar configuration and low cost. The antenna has been developed using ring shaped ring on rectangular shaped substrate dimension of about 60 mm X 60 mm. The fleece substrate material has bring used with a permittivity of 1, dielectric constant of 3.2, and thickness of 3 mm. The antenna is designed with number of turns in the ring to increase the gain and good bidirectional radiation characteristics. Computer Simulation Tool (HFSS) is used to simulate the proposed antenna. The analysis of antenna has been performed based on the parameters such as directivity, gain and bandwidth.



## INTRODUCTION

The main idea is to design an underwater communication antenna for Industrial-Scientific-Medical band and tracking applications. A compact and underwater communication ring antenna with notch characteristic is designed using a flexible substrate material and coplanar waveguide (CPW) feeding technique[1,2]. The frequency band is obtained by introducing two U-shaped connected slots in the radiation ring and a rectangular slot in the ground plane.

Underwater communication antennas are essentially any antenna that is specifically designed to function while being telemetry. The textile or cloth based underwater communication antenna is used to communicate the voice[3,4], data or biotelemetry signals at

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high data rates. The underwater communication antenna having the features like light weight, conformal, need to be hidden and it do not affect the health of user. The synthetic or natural materials are used as substrate to manufacture the textile[5,6] or cloth-based underwater communication antennas. These materials are cotton, liquid crystal polymer (LCP), polyester, fleece fabric, foam, nomex, nylon and copper coated fabric. These techniques significantly gain, bandwidth, directivity of the ring antennas with considerable size reduction. The CPW- fed line technique is also used to achieve bidirectional and unidirectional with multiband operation[7].

A ring antenna consists of a radiating ring one side of a dielectric substrate which has a ground plane on the other side. The ring is generally made of conducting material such as copper or gold and can take any possible shape. The radiating ring and the feed lines are usually photo etched on the dielectric substrate. Arrays of antennas can be photo etched on the substrate along with their feeding networks. Circuits make a wide variety of antennas possible through the use of the simple photo etching techniques. Ring antennas are attractive due to their conformal properties[8,9]. So far they have been mostly fabricated on substrates which typically exhibit dielectric constants no greater than 10. However, high permittivity materials (>10) have the property of increasing electric field intensity in their volume.

## RING ANTENNA AND ITS DESIGN PARAMETERS

The rectangular shaped ring antenna is by far the most widely used configuration[10]. It is very easy to analyze using both the transmission line model and cavity models, which are most accurate for thin substrates. The parameters to design rectangular ring antennas are Width of the ring, Effective dielectric constant, Effective length, Length of the ring, Frequency of operation.

Finding the width of the ring

$$w = \frac{c}{2f_r}\sqrt{\frac{2}{\varepsilon_r+1}} \quad (1)$$

where,

$c$ is speed of light (m/s)

$f_r$ is the resonant frequency (GHZ)

$w$ is the width of the ring (mm)

Finding the effective dielectric constant

$$\varepsilon_{reff} = \frac{\varepsilon_r+1}{2} + \frac{\varepsilon_r-1}{2}[1 + 12\ h/w]^{-1/2} \quad (2)$$

where,

$\varepsilon_r$ is the relative permittivity

$h$ is the height of the substrate (mm)

Finding the effective length of the ring

$$L_{eff} = \frac{c}{2f_r\sqrt{\varepsilon_{reff}}} \quad (3)$$

where,

$\varepsilon_{reff}$ is the effective dielectric constant

$f_r$ is the resonant frequency (GHZ)

Length of the ring

$$L = L_{eff} - 2\Delta L \quad (4)$$

where

$$\Delta L = 0.412h \frac{(\varepsilon_{reff} + 0.3)\left(\frac{w}{h} + 0.264\right)}{(\varepsilon_{reff} - 0.258)\left(\frac{w}{h} + 0.8\right)} \quad (5)$$

Frequency of operation

$$f_c = \frac{c}{2L\sqrt{\varepsilon_r}} \quad (6)$$

where

$f_c$ is the cut-off frequency

## DESIGN RING ANTENNA

The design is carried out with the basic rectangular ring structure as shown in fig.1. This antenna has been developed with the ring dimension 4 cm radius. Design is carried out by using FR4substrate material with $\varepsilon_r$ = 3.2 and thickness of the substrate as 1.6 mm. The underwater communication antenna is designed to operate at the frequency range from 1.8 GHz – 5 GHz. The design is carried out by Ansoft HFSS version 13 software. The designed antenna has provided a bandwidth with -32.5 dB return loss.

**Figure – 1:** *Design of Ring Antenna*

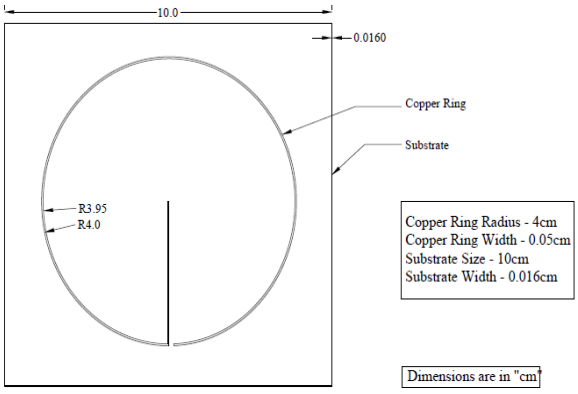
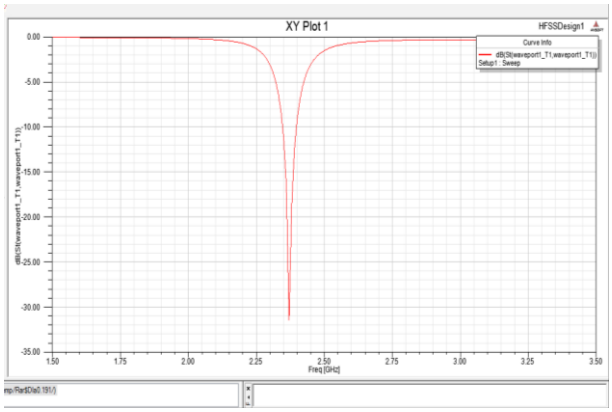


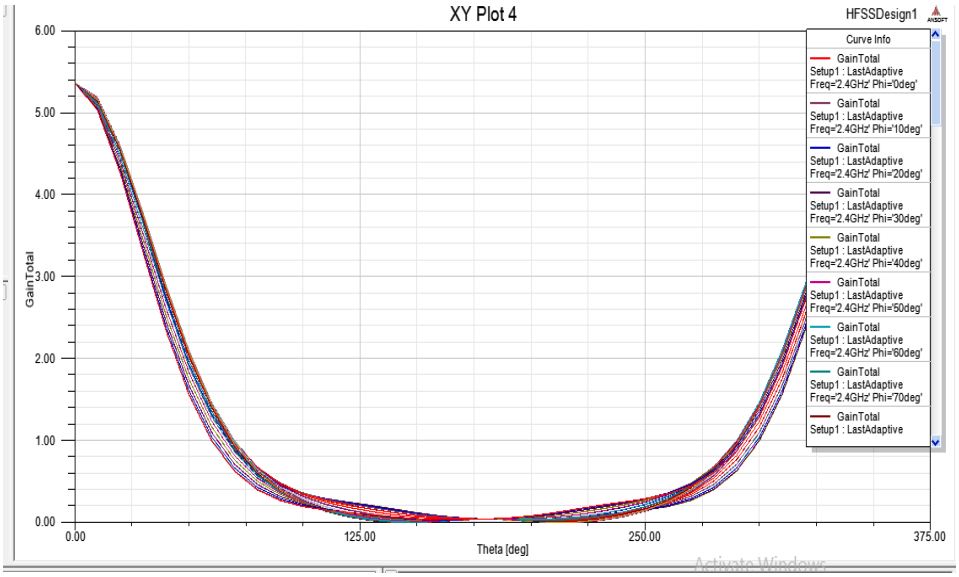

Fig.2. represents the frequency response of the basic ring antenna. Here the antenna operates at the frequency range of 2.2 GHz with the return loss of -8dB.

**Figure – 2:** *Frequency Response of Ring Antenna*



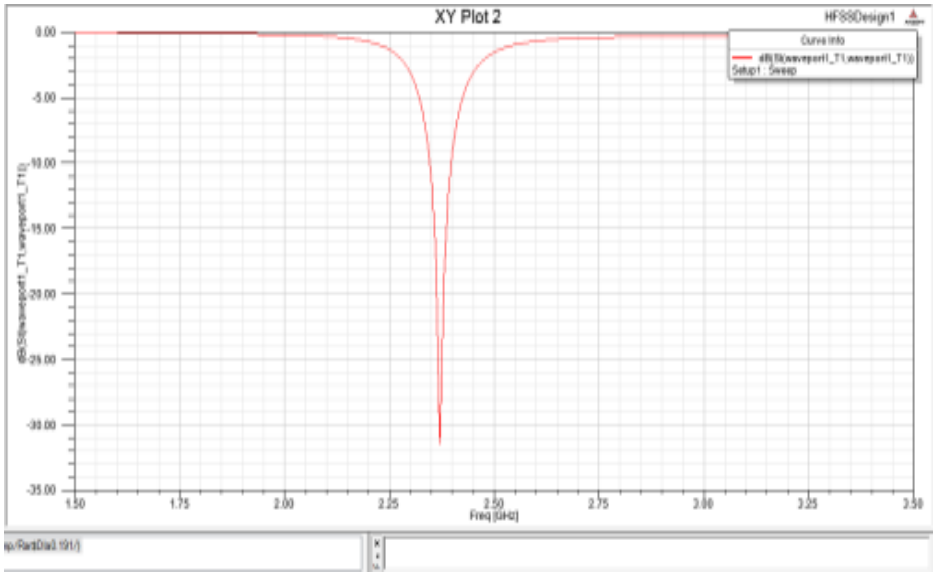
In electromagnetic, an antenna's power gain or simply gain is a key performance number which combines the antenna's directivity and electrical efficiency.

**Figure – 3:** *Gain of Ring Antenna*




The gain of the basic ring antenna is shown in Fig.3.The red part in the graph shows the maximum radiation region of the ring antenna. The CPW-fed ultra-wideband antenna with dual band-notch characteristic is designed for UWB applications.Fig.4. The resonant frequency of the antenna is nearly 7 GHz. It covers only small range of bandwidth.

**Figure – 4:** *Return Loss of Slot Antenna with Ring Shaped*




## RADIATION PATTERN OF THE ANTENNA

The radiation pattern of the proposed antenna is shown in Fig.5. The radiation pattern is found to be directional, which is radiating in a particular direction. Fig.6. The radiation pattern describes the relative strength of the radiated field in particular directions from the antenna, at a fixed or constant distance.

**Figure – 5:** *Radiation Pattern of the Antenna*

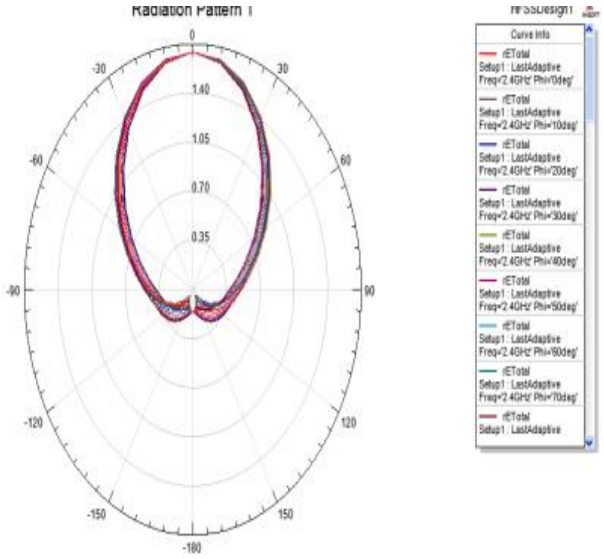
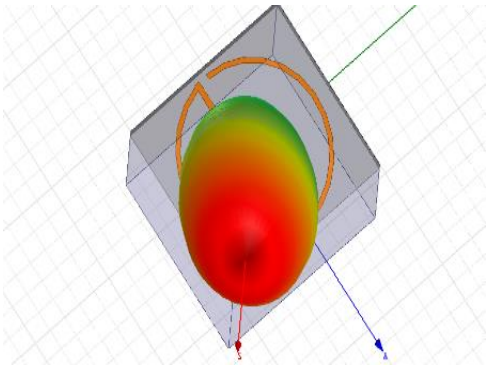
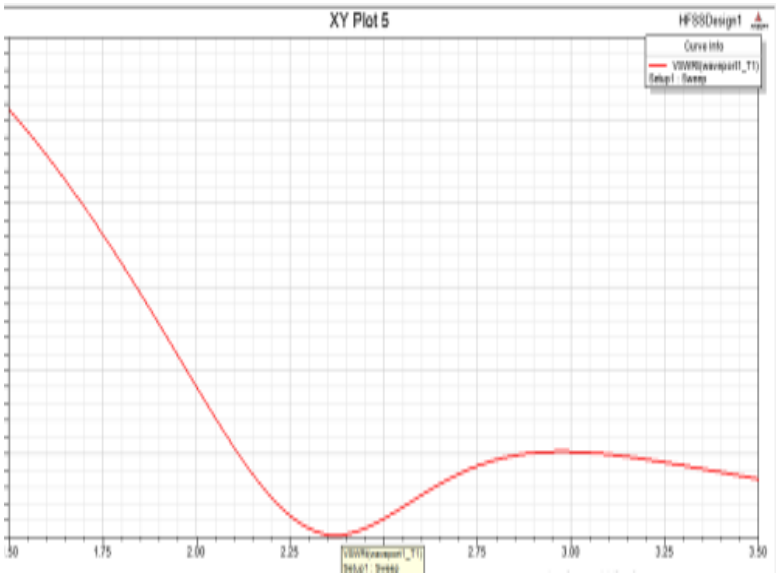



**Figure – 6:** *Radiation Pattern in 3D*



The Fig.7.represents the VSWR of the proposed antenna. Voltage standing wave ratio is a measure of impedance matching of loads to the characteristic impedance of a transmission line or waveguide.

**Figure – 7:** *VSWR of the Antenna*



## CONCLUSION

A compact underwater communication ring antenna has been proposed for communication purposes, which includes tracking and navigation, mobile communication and public safety. Ring is a representative candidate for any underwater communication application, as it can be made conformal for integration into clothing. The antenna consists of ring shaped radiating ring which is made up of perfect electric conductor. The FR4 material is used as a dielectric with the thickness of 5mm which provides flexibility and also it radiate perpendicularly to the planar structure, their ground plane efficiently shields the underwater particles. The dimension of the antenna is 8cm X 8cm. The antenna has been designed to operate at a frequency of around 2.45GHz used for various wireless applications with the gain of 1.954 db. The design is carried out by Computer Simulation Tool (HFSS) software.

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